Space Weather Technical Forecast

Issued on Friday 27 December 2024 at 00:56 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Occasional R1/R2 radio blackouts expected throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with two M-class flares observed. The peak flare measured M7.3 at 26/0315 UTC from AR3938 with some contribution from AR3933. There are currently thirteen sunspot regions on the disc, with two small unipolar regions currently unnumbered. The largest region on the disc remains AR3936 approaching north centre disc, but this still appears to have a largely straightforward magnetic structure. AR3938 in the northeast has been the most active region of late, and is showing some minor magnetic complexity. AR3928 and AR3933 in the southwest both faded a little, with both also showing a reduction in magnetic complexity. AR3932 at south centre disc has seen most of its leading spots fade. The other groups appear small and simple at this time.

There have been several larger far sided CMEs in the last 24 hours, making near sided CME analysis more difficult. No obviously Earth-directed CMEs observed in available imagery, although investigation continues into a number of features.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE, showed a return to background conditions after recent high speed stream influence. The wind speed fell from slightly elevated levels around 430km/s to background levels around 350km/s. The density was initially below average, with a slow rise towards average levels. The Interplanetary Magnetic Field was weak throughout below 5nT. The north-south component, Bz, varied weakly between +/-3nT. The phi angle was negative (towards the Sun) throughout. Geomagnetic activity was Quiet (Kp 0-1).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES 18 showed a continuing gradual decline, well below the S1/Minor Radiation Storm threshold.

High energy electron flux (greater than 2MeV) at GOES16 was at moderate levels, peaking at 26/1615UTC near 868pfu. The associated 24-hour fluence was below the Active (1e8 integrated flux) threshold on a flat trend. The 27/0000UTC observation was 3.4e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Occasional M-class flares are likely, with a slight chance of isolated X-class flares throughout.

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Solar Wind / Geomagnetic Activity: The CME from 23 Dec is now considered likely to have missed Earth. Whilst no further CMEs are currently expected, there have been numerous CMEs in recent days and confidence in this aspect of the forecast is lower than usual. Solar winds have now declined to background levels after the recent connection to CH01/-. Wind speeds expected to remain at background or perhaps slightly elevated levels through the period in the absence of CME enhancement.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, but with a very slight risk of Active to G1/Minor Storm intervals should any glancing CME effects occur.

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor Radiation Storm or greater enhancements during the period. In the absence of any further notable flares, ongoing proton counts should continue to ease towards background levels in the coming days.

Electron flux levels remain Moderate but are expected to gradually ease into the period. There remains a slight chance of exceeding Active Fluence levels, particularly to start the period, but this risk gradually reducing.

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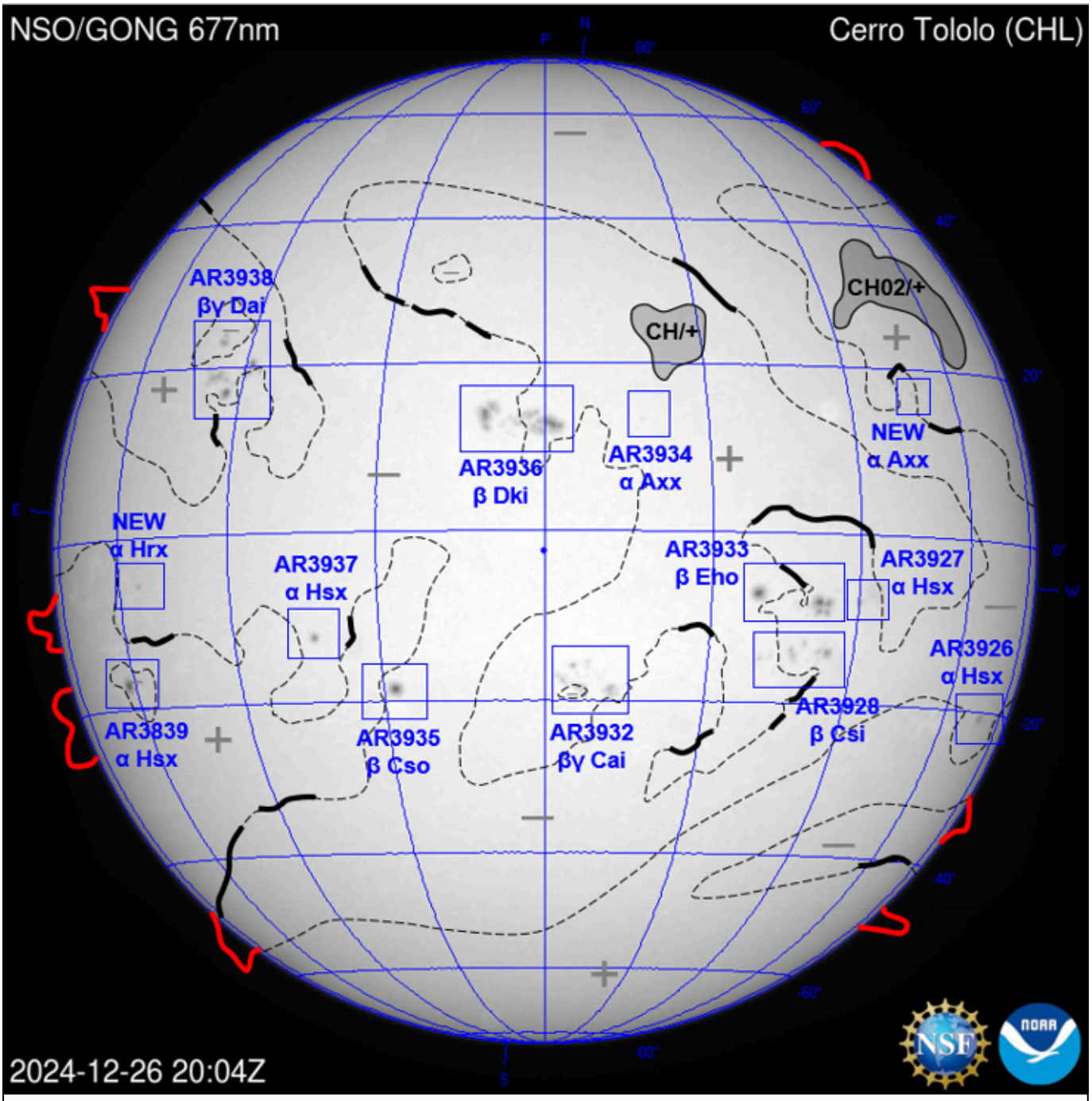
Figure 1: Solar Synoptic Map valid 26/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

The CME generated by the M8.9 flare from AR3923 and a nearby, sympathetic filament lift-off on 23 Dec is now considered likely to have missed Earth. Whilst no other significant Earth directed CMEs are currently expected in the forecast, there have been numerous CMEs in recent days, some of which have been analysed close to the Earth-Sun line and may present the risk of minor glancing enhancement into the period. As such confidence in this aspect of the forecast is lower than usual.

Solar winds have now declined to background levels after the recent connection to CH01/-. Some further enhancement is possible but unlikely on Day 1 (27 Dec) from CH02/+ located in the northwest disc. MOSWOC ENLIL output persists in showing a HSS from an uncertain source at the start of this period, but this is viewed as erroneous with current output not preferred. Solar wind speeds are expected to remain background levels to start the period. An increase to perhaps slightly elevated levels is possible at times, particularly into Days 3 and 4 (29-30 Dec) with enhancement perhaps from the centre disk, but also with the potential for transitory CME enhancements as discussed above.

Geomagnetic activity is expected to be chiefly Quiet to Unsettled throughout, but with a very slight risk of Active to G1/Minor Storm intervals should any more impactful CME effects occur.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X-Ray Flares

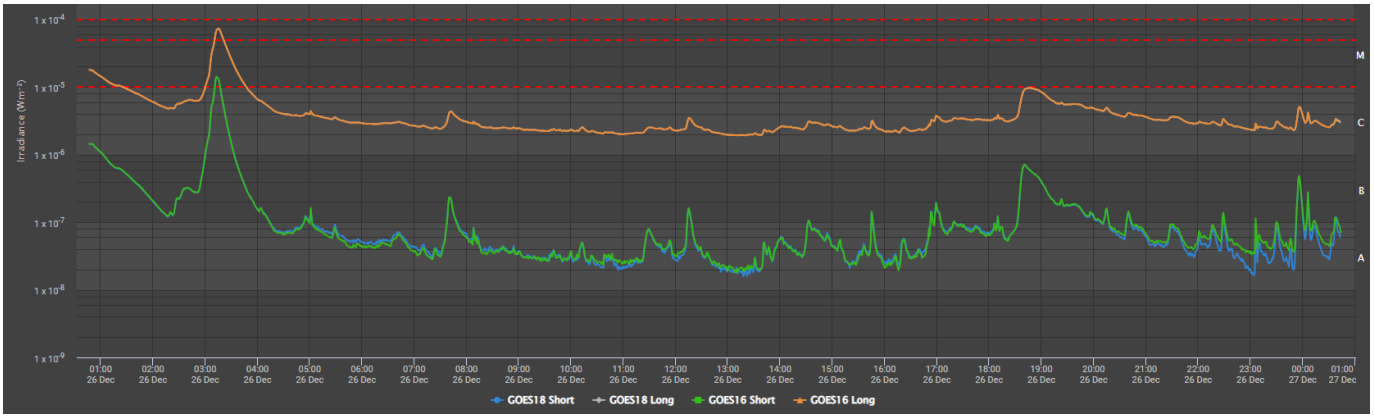
The Penticton 10.7cm flux has been on a strong rising trend in recent days as the number of larger sunspot regions has increased, reaching a peak for this rotation, but values perhaps showing sign of some stabilisation with slight decline among a number of the previously large groups. Of the thirteen sunspot regions on the disc at present, the largest region on the disc remains AR3936 approaching north centre disc, this regions has been the source of flare activity but still appears to have a generally straightforward magnetic structure. AR3938 in the northeast has been the most active region of late, and is showing the most notable magnetic complexity. AR3928 and AR3933 in the southwest have both seen fading and simplification, with AR3928 also showing a reduction in size. AR3932 at south centre disc has seen most of its leading spots fade, but maintains some magnetic complexity. Remaining groups appear small and simple at this time.

Recurrence suggests the potential for further sunspot regions to round the eastern limb later in the period, with this supported by recent far-side CME activity although far-side sounding output is not showing any significant regions. None of the larger sunspot regions leave the disc in the four day forecast period.

The assessment of any new regions notwithstanding, flare risk looks to remain elevated during the period and occasional M-class flares remain likely, with a slight chance of X-class flares maintained throughout, pending further developments.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	10	10	10	10

Figure 2: Latest 24hr GOES16/18 X-Ray trace.



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Solar Radiation Storms (High Energy Protons)

High energy proton counts are slowly declining and should continue to ease towards typical background values in the coming days in the absence of significant flaring. There remains a slight chance of S1/Minor Solar Radiation storms or greater, should any significant flares occur from the larger regions on the disc as they move into more favourable western locations for connection with Earth. That said, none of these regions currently show any significant magnetic complexity, likely lowering the risk of significant proton enhancement somewhat.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

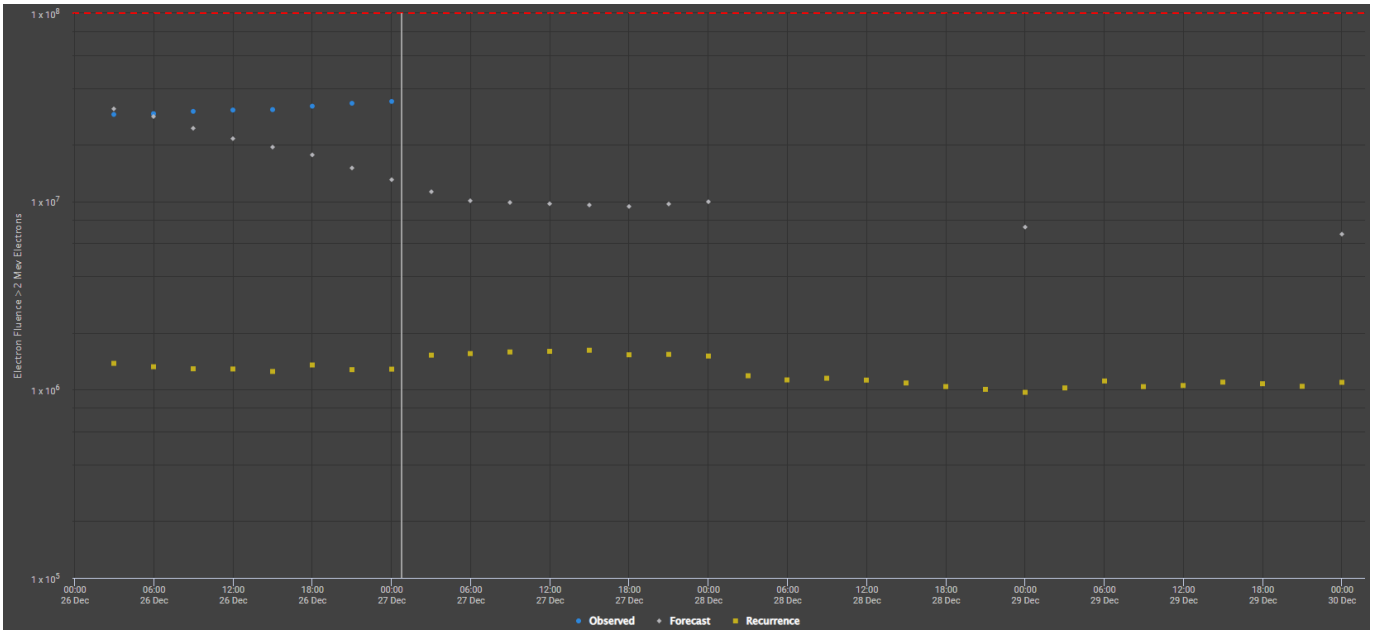
Current high energy electron flux has been at moderate levels in the last 24 hours. Now that the solar wind pressure from CH01/- has eased, diurnally high electron flux levels are possible during this period. Electron flux may show a slight rise in the short term, followed by a very gradual decline over the following days.

Electron fluence has been steady over the last 24 hours, and is most likely to remain below the Active threshold. However, there is a slight chance of exceeding Active levels through this period given current flux levels and forecast uncertainty.

MOSWOC REFM is now showing a steady forecast through the next three days, which is not unreasonable. Given the expected lack of significant CME influence in the coming days the forecast can likely be followed with greater confidence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	20	15	10	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 3: Latest MOSWOC REFM model output.



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